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Nguyen

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(54) **ENGINE INCLUDING VALVE LIFT MECHANISM WITH STRESS REDUCTION FEATURES**

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(51) **Int. Cl.**
F01L 1/18 (2006.01)

(52) **U.S. Cl.** **123/90.39**; 123/90.44; 29/888.2; 74/559

(58) **Field of Classification Search** 123/90.39, 123/90.44; 29/888.2; 74/559, 567, 569
See application file for complete search history.

(56) **References Cited**

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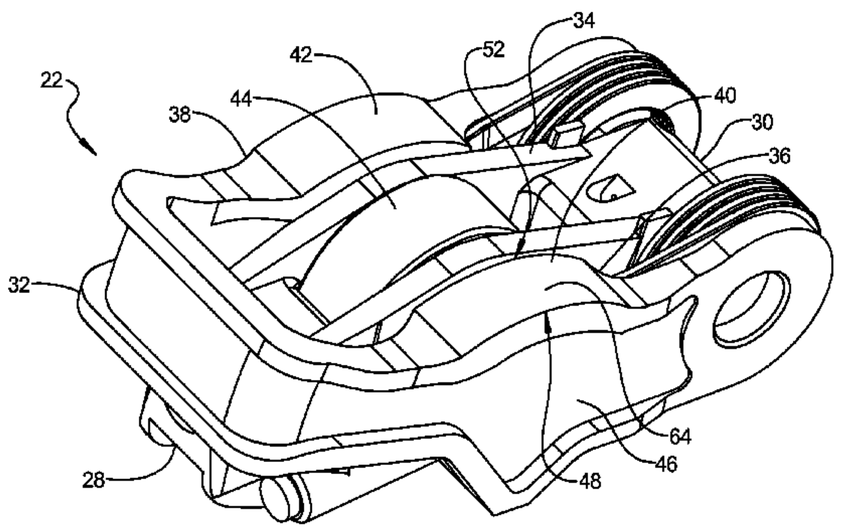
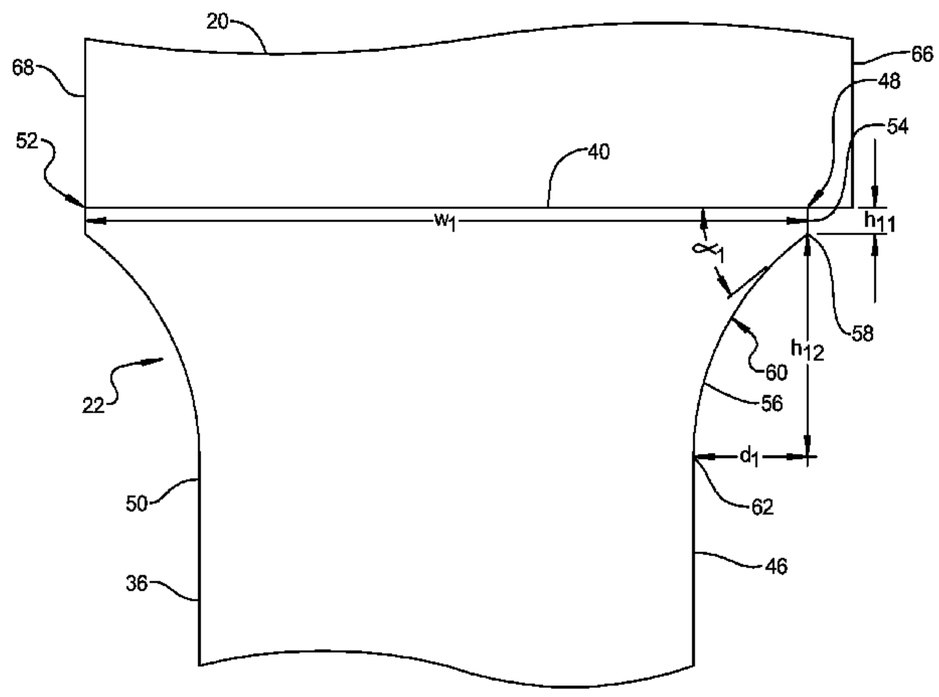
(57) **ABSTRACT**

An engine assembly may include an engine structure supporting a camshaft and a valve lift mechanism. The camshaft may include a cam lobe and may define a longitudinally extending rotational axis. The valve lift mechanism may define a longitudinally extending cam engagement surface and a first side wall. The cam engagement surface may be engaged with the cam lobe at a first location. The first side wall may be fixed to the cam engagement surface and may include first and second portions. The first portion may extend from the cam engagement surface. The second portion may extend continuously inward from an end of the first portion. The inward extent of the second portion may be greater than or equal to a first height at the first location defined from the cam engagement surface to the end of the first portion.

20 Claims, 4 Drawing Sheets





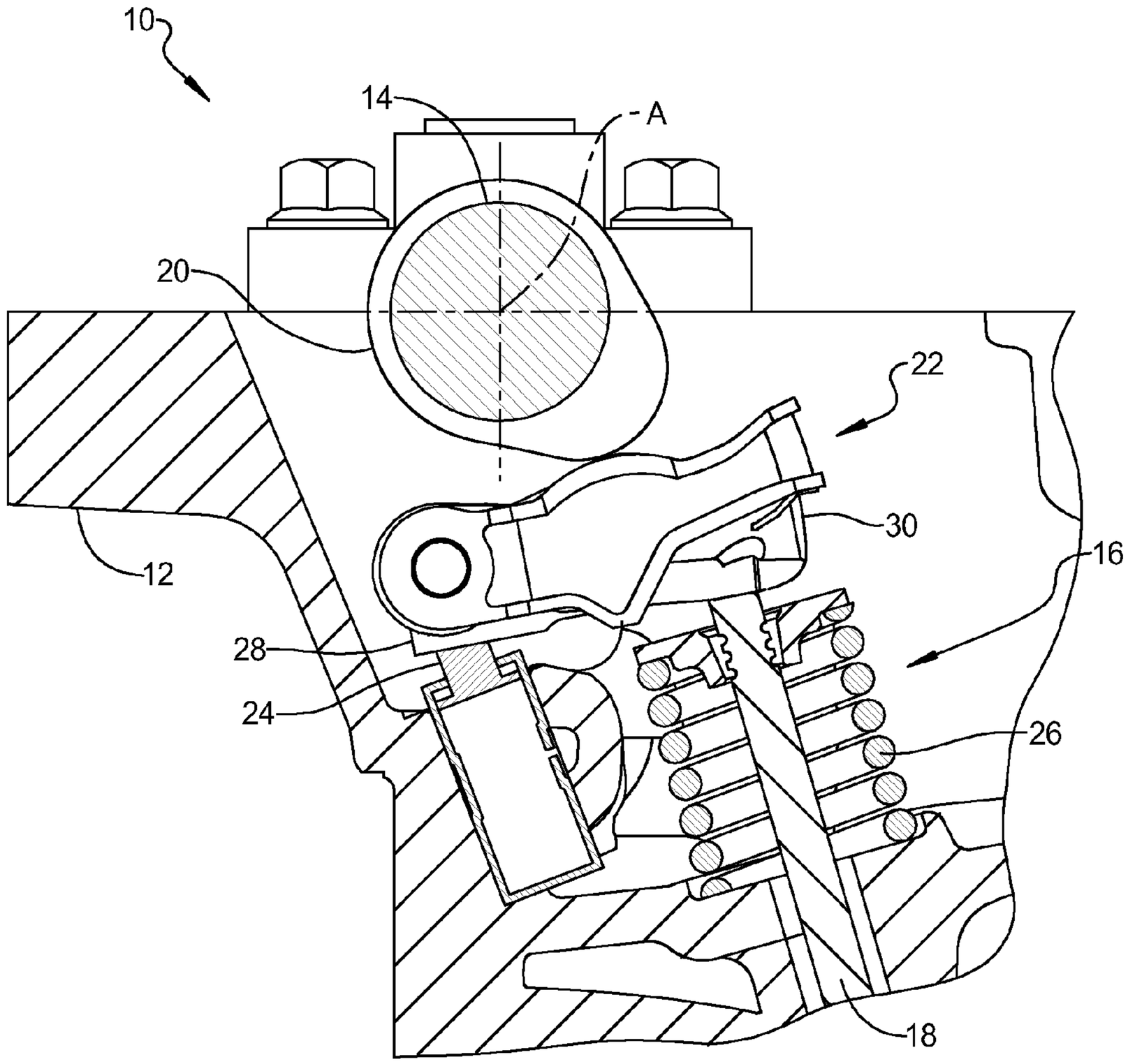


FIG 1

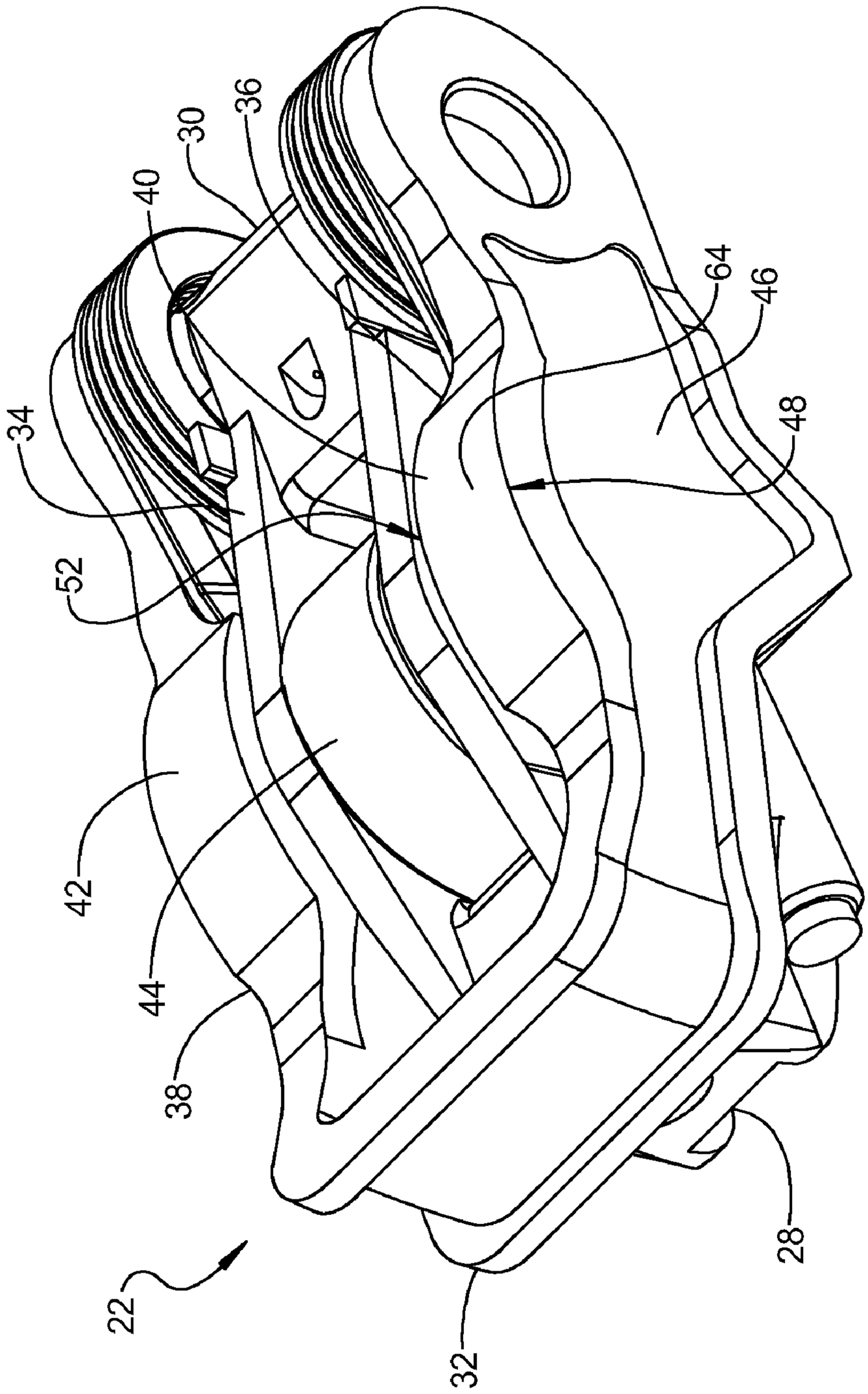


FIG 2

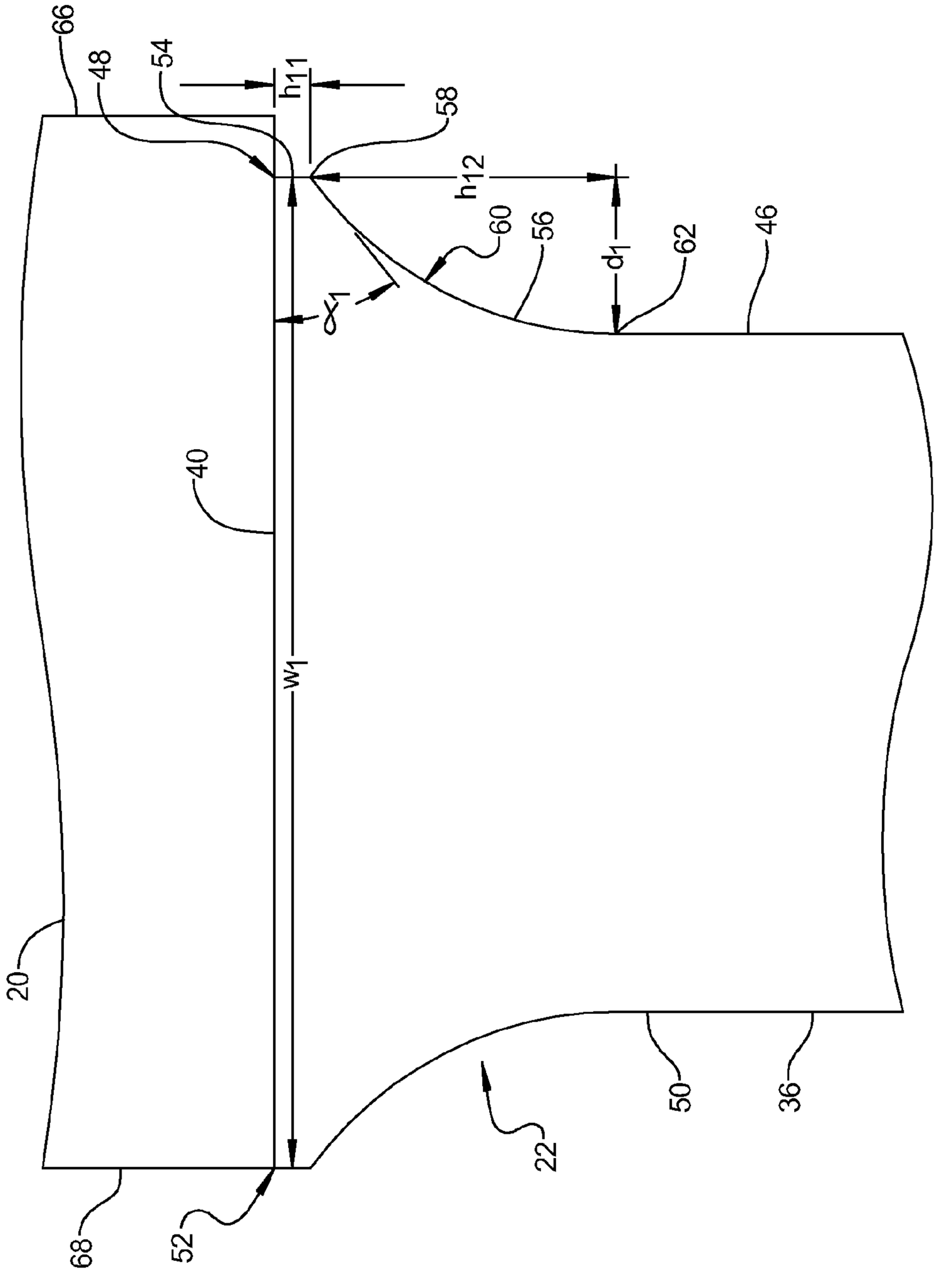


FIG 3

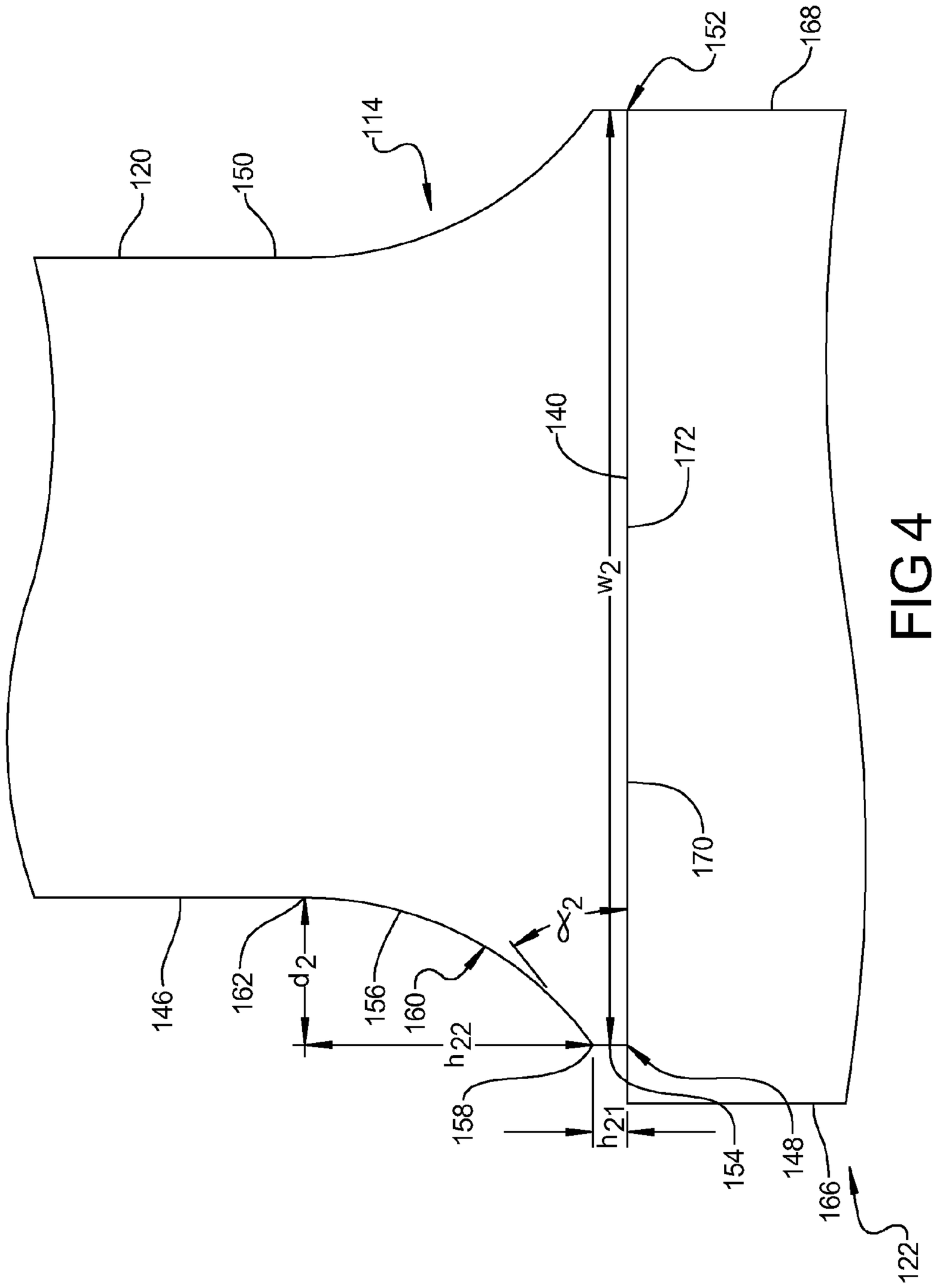

120
150
114
152
168
140
172
W2
170
α2
146
162
d2
156
160
h22
158
h21
154
148
166
122

FIG 4

ENGINE INCLUDING VALVE LIFT MECHANISM WITH STRESS REDUCTION FEATURES

FIELD

The present disclosure relates to stress reduction features in engine valve lift mechanisms.

BACKGROUND

This section provides background information related to the present disclosure which is not necessarily prior art.

Engine assemblies may include valve lift mechanisms engaged with camshaft lobes for actuation of intake and exhaust valves. During valve lift events a load is applied on the valve lift mechanisms and cam lobes as a result of the engagement therebetween. The engagement between the valve lift mechanisms and lobes may result in stress concentration at edge regions thereof.

SUMMARY

An engine assembly may include an engine structure, a camshaft and a valve lift mechanism. The camshaft may include a cam lobe and may be rotationally supported on the engine structure defining a longitudinally extending rotational axis. The valve lift mechanism may be supported on the engine structure and may define a body including a longitudinally extending cam engagement surface and a first side wall.

The longitudinally extending cam engagement surface may be engaged with the cam lobe at a first location and may define first and second longitudinal end regions opposite one another. The first side wall may be fixed to the cam engagement surface and may include first and second portions. The first portion may extend from the cam engagement surface. The second portion may extend continuously inward from an end of the first portion toward the second longitudinal end region. The inward extent of the second portion may be greater than or equal to a first height at the first location defined from the cam engagement surface to the end of the first portion.

Further areas of applicability will become apparent from the description provided herein. The description and specific examples in this summary are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings described herein are for illustrative purposes only and are not intended to limit the scope of the present disclosure in any way.

FIG. **1** is a fragmentary section view of an engine assembly according to the present disclosure;

FIG. **2** is a perspective view of a valve lift mechanism of the engine assembly of FIG. **1**;

FIG. **3** is a schematic illustration of a portion of the valve lift mechanism shown in FIG. **2**; and

FIG. **4** is a schematic illustration of a cam lobe including the features of the present disclosure.

Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings.

DETAILED DESCRIPTION

Examples of the present disclosure will now be described more fully with reference to the accompanying drawings. The following description is merely exemplary in nature and is not intended to limit the present disclosure, application, or uses.

With reference to FIG. **1**, an engine assembly **10** is illustrated. The engine assembly **10** may include an engine structure **12**, a camshaft **14** rotationally supported on the engine structure **12**, a valve lift assembly **16** and a valve **18**. In the present non-limiting example, the engine assembly **10** is shown as an overhead camshaft engine. However, the present disclosure is not limited to overhead camshaft arrangements and applies equally to cam-in-block arrangements. It is further understood that the present disclosure applies equally to intake and exhaust valve lift assemblies.

In the present non-limiting example, the engine structure **12** may include a cylinder head. The camshaft **14** may include cam lobes **20** (one shown) and may define a longitudinally extending rotational axis (A). The valve lift assembly **16** may include a valve lift mechanism **22**, a lash adjustor **24** and a valve spring **26**. By way of non-limiting example, the valve lift mechanism **22** may form a rocker arm including a first lateral end **28** supported for pivotal displacement by the engine structure and a second lateral end **30** engaged with the valve **18**. However, it is understood that the present disclosure is not limited to rocker arms.

The lash adjuster **24** may support the first lateral end **28** of the valve lift mechanism **22**. The valve spring **26** may be engaged with the engine structure **12** and may bias the valve **18** into engagement with the valve lift mechanism **22** and to a closed position. With additional reference to FIG. **2**, the valve lift mechanism **22** may form a multi-step rocker arm including an outer arm **32** and an inner arm **34**. The outer arm **32** may include first and second portions **36**, **38**, each defining a longitudinally extending cam engagement surface **40**, **42**, and the inner arm **34** may include a roller member **44**. The first and second portions **36**, **38** of the outer arm **32** may be similar to one another. Therefore, for simplicity, the first portion **36** will be described with the understanding that the description applies equally to the second portion **38**.

The valve lift mechanism **22** may be operable in a first mode where the outer arm **32** is displaceable relative to the inner arm **34** and a second mode where the outer arm **32** is fixed for displacement with the inner arm **34**. However, the present disclosure is not limited to such arrangements and applies equally to a variety of other valve lift arrangements including, but not limited to, single arm lift mechanisms.

With reference to FIGS. **2** and **3**, the first portion **36** of the valve lift mechanism **22** may include a first sidewall **46** extending from a first longitudinal end region **48** of the cam engagement surface **40** and a second sidewall **50** extending from a second longitudinal end region **52** of the cam engagement surface **40** opposite the first longitudinal end region **48**. The first portion **36** may form a monolithic body including the cam engagement surface **40** and the first and second sidewalls **46**, **50**. Therefore, the cam engagement surface **40** may form a slider pad fixed for rotation with the first and second sidewalls **46**, **50**.

The first and second sidewalls **46**, **50** may define a height of the first portion **36** of the valve lift mechanism **22**. The first and second sidewalls **46**, **50** may be generally similar to one another. Therefore, the first sidewall **46** will be described with the understanding that the description applies equally to the second sidewall **50**. The first sidewall **46** may include a first portion **54** extending from the cam engagement surface **40** and a second portion **56** extending from an end **58** of the first portion **54**.

The second portion **56** may extend continuously inward from the first portion **54** in a longitudinal direction from the first longitudinal end region **48** toward the second longitudi-

nal end region **52**. In the present non-limiting example, the second portion **56** may form a recess **60** in the first sidewall **46** defining a curved surface. However, it is understood that the second portion **56** may alternatively extend linearly from the first portion **54**. By way of non-limiting example, the second portion **56** may extend at an angle (α_1) of ten to eighty degrees relative to the cam engagement surface **40** at an interface between the first and second portions **54**, **56** defined at the end **58** of the first portion **54**.

The second portion **56** may include an end **62** defining a maximum depth (d_1). The depth (d_1) may be the maximum continuously inward extent from the end **58** of the first portion **54**. It is understood that the depth (d_1) may remain constant, decrease or increase after the end **62** of the second portion **56**. In present non-limiting example, the end **58** is illustrated longitudinally aligned with the terminal end of the first longitudinal end region **48** of the cam engagement surface **40**. However, it is understood that alternate arrangements may exist where the end **58** is located longitudinally inward or outward from the terminal end of the first longitudinal end region **48**.

The first portion **54** may define a height (h_{11}) from the cam engagement surface **40** to the end **58**. The height (h_{11}) may define a minimum thickness region of the first portion **36** of the valve lift mechanism **22** along the cam engagement surface **40**. By way of non-limiting example, the height (h_{11}) may be less than forty percent of the longitudinal extent, or width, (w_1) of the cam engagement surface **40**. The depth (d_1) of the second portion **56** may be greater than or equal to the height (h_{11}). The depth (d_1) may be less than the longitudinal extent, or width, (w_1) of the cam engagement surface **40**. The height (h_{12}) of the second portion **56** may continuously increase from the end **58** of the first portion **54** to the end **62** of the second portion **56**. The height (h_{12}) may be greater than the height (h_{11}).

In the present non-limiting example, the cam engagement surface **40** defines a curved profile along its lateral extent. The height (h_{11}) at the end **58** and the depth (d_1) may be defined at a peak **64** (FIG. **2**) of the curved profile of the cam engagement surface **40**. The height (h_{11}) may be defined generally perpendicular to the cam engagement surface **40**. More specifically, and by way of non-limiting example, the height (h_{11}) at the end **58** and the depth (d_1) may be defined along a majority of the curved profile of the cam engagement surface **40**. The lateral extent of the cam engagement surface **40** engaged with the cam lobe **20** may include the height (h_{11}) at the end **58** and the depth (d_1) along the lateral extent.

As illustrated in FIG. **3**, the cam lobe **20** may include first and second longitudinal ends **66**, **68** forming edges. The first longitudinal end region **48** may be located longitudinally between the first and second longitudinal ends **66**, **68** of the cam lobe **20**. The structure defined by the second portion **56** of the first sidewall **46** discussed above may generally reduce contact stress on the valve lift mechanism **22**. As indicated above, it is understood that the features of the first portion **36** of the valve lift mechanism **22** may be incorporated into a valve lift mechanism having a single arm.

Alternatively, and with reference to FIG. **4**, the features of the first and second portions **54**, **56** of the valve lift mechanism **22** described above may be incorporated into a cam lobe **120** of a camshaft **114**. The cam lobe **120** may include a peak **170** defining an outer circumferential surface **172**. The cam lobe **120** may include a first sidewall **146** extending from a first longitudinal end region **148** of the surface **172** and a second sidewall **150** extending from a second longitudinal end region **152** of the surface **172** opposite the first longitudinal end region **148**.

The first and second sidewalls **146**, **150** may define a height of the peak **170** relative to the base circle region of the cam lobe **120**. The first and second sidewalls **146**, **150** may be generally similar to one another. Therefore, the first sidewall **146** will be described with the understanding that the description applies equally to the second sidewall **150**. The first sidewall **146** may include a first portion **154** extending from the surface **172** and a second portion **156** extending from an end **158** of the first portion **154**.

The second portion **156** may extend continuously inward from the first portion **154** in a longitudinal direction from the first longitudinal end region **148** toward the second longitudinal end region **152**. In the present non-limiting example, the second portion **156** may form a recess **160** in the first sidewall **146** defining a curved surface. However, it is understood that the second portion **156** may alternatively extend linearly from the first portion **154**. By way of non-limiting example, the second portion **156** may extend at an angle (α_2) of ten to eighty degrees relative to the surface **172** at an interface between the first and second portions **154**, **156** defined at the end **158** of the first portion **154**.

The second portion **156** may include an end **162** defining a maximum depth (d_2). The depth (d_2) may be the maximum continuously inward extent from the end **158** of the first portion **154**. It is understood that the depth (d_2) may remain constant, decrease or increase after the end **162** of the second portion **156**. In present non-limiting example, the end **158** is illustrated longitudinally aligned with the terminal end of the first longitudinal end region **148** of the surface **172**. However, it is understood that alternate arrangements may exist where the end **158** is located longitudinally inward or outward from the terminal end of the first longitudinal end region **148**.

The first portion **154** may define a height (h_{21}) from the surface **172** to the end **158**. The height (h_{21}) may define a minimum thickness region of the cam lobe **120** along the surface **172**. By way of non-limiting example, the height (h_{21}) may be less than forty percent of the longitudinal extent, or width, (w_2) of the surface **172**. The depth (d_2) of the second portion **156** may be greater than or equal to the height (h_{21}). The depth (d_2) may be less than the longitudinal extent, or width, (w_2) of the surface **172**. The height (h_{22}) of the second portion **156** may continuously increase from the end **158** of the first portion **154** to the end **162** of the second portion **156**. The height (h_{22}) may be greater than the height (h_{21}).

In the present non-limiting example, the surface **172** defines a curved profile along its lateral extent. The height (h_{21}) may be defined generally perpendicular to the surface **172**. More specifically, and by way of non-limiting example, the height (h_{21}) at the end **158** and the depth (d_2) may be defined along a majority of the curved profile of the cam lobe **120** that extends radially outward from the base circle region.

As illustrated in FIG. **4**, the valve lift mechanism **122** may include first and second longitudinal ends **166**, **168** forming edges of the cam engagement surface **140**. The first longitudinal end region **148** may be located longitudinally between the first and second longitudinal ends **166**, **168** of the valve lift mechanism **122**. The structure defined by the second portion **156** of the first sidewall **146** discussed above may generally reduce contact stress on the cam lobe **120**.

What is claimed is:

1. A valve lift mechanism comprising:

a cam engagement surface adapted to engage a cam lobe of a camshaft at a first location, extending longitudinally relative to a rotational axis of the camshaft and defining first and second longitudinal end regions opposite one another; and

a first sidewall fixed to the cam engagement surface and including a first portion extending from the cam engagement surface and a second portion extending continuously inward from an end of the first portion toward the second longitudinal end region, a continuous inward extent of the second portion being greater than or equal to a first height at the first location defined from the cam engagement surface to the end of the first portion.

2. The valve lift mechanism of claim **1**, wherein a second height greater than the first height is defined from the end of the first portion to a location on the first sidewall where the continuous inward extent of the second portion is defined.

3. The valve lift mechanism of claim **1**, wherein a height of the second portion is continuously increasing along the continuous inward extent thereof.

4. The valve lift mechanism of claim **1**, wherein the first height is less than 40 percent of a longitudinal extent of the cam engagement surface.

5. The valve lift mechanism of claim **1**, wherein the first height is defined perpendicular to the cam engagement surface at the first location.

6. The valve lift mechanism of claim **1**, wherein the first height defines a minimum thickness region along the cam engagement surface.

7. The valve lift mechanism of claim **1**, wherein the second portion extends from the first portion at an angle of between 10 degrees and 80 degrees relative to the cam engagement surface.

8. The valve lift mechanism of claim **1**, wherein the first portion of the first sidewall is defined at a terminal end of the cam engagement surface.

9. The valve lift mechanism of claim **1**, wherein the continuous inward extent of the second portion is less than one-half of a longitudinal extent of the cam engagement surface.

10. The valve lift mechanism of claim **1**, wherein the valve lift mechanism forms a rocker arm including a first end adapted to be supported for pivotal displacement on an engine structure and a second end adapted to engage a valve member, the cam engagement surface forming a slider pad rotationally fixed relative to the first and second ends and including an arcuate surface extending in a direction from the first end to the second end and defining a peak aligned with the first and second portions of the first sidewall.

11. An engine assembly comprising:

an engine structure;

a camshaft rotationally supported on the engine structure, defining a longitudinally extending rotational axis and including a cam lobe; and

a valve lift mechanism supported on the engine structure and defining a body including:

a longitudinally extending cam engagement surface engaged with the cam lobe at a first location and defining first and second longitudinal end regions opposite one another; and

a first sidewall fixed to the cam engagement surface and including a first portion extending from the cam engagement surface and a second portion extending continuously inward from an end of the first portion toward the second longitudinal end region, a continuous inward extent of the second portion being greater than or equal to a first height at the first location defined from the cam engagement surface to the end of the first portion.

12. The engine assembly of claim **11**, wherein a second height greater than the first height is defined from the end of the first portion to a location on the first sidewall where the continuous inward extent of the second portion is defined.

13. The engine assembly claim **11**, wherein a height of the second portion is continuously increasing along the continuous inward extent thereof.

14. The engine assembly of claim **11**, wherein the first height is less than 40 percent of a longitudinal extent of the cam engagement surface.

15. The engine assembly of claim **11**, wherein the first height is defined perpendicular to the cam engagement surface at the first location.

16. The engine assembly of claim **11**, wherein the first height defines a minimum thickness region along the cam engagement surface.

17. The engine assembly of claim **11**, wherein the second portion extends from the first portion at an angle of between 10 degrees and 80 degrees relative to the cam engagement surface.

18. The engine assembly of claim **11**, wherein the first portion of the first sidewall is located longitudinally between first and second longitudinal ends of the cam lobe.

19. The engine assembly of claim **11**, wherein the continuous inward extent of the second portion is less than one-half of a longitudinal extent of the cam engagement surface.

20. The engine assembly of claim **11**, wherein the valve lift mechanism forms a rocker arm including a first end supported for pivotal displacement on the engine structure and a second end engaged with a valve member, the cam engagement surface forming a slider pad rotationally fixed relative to the first and second ends and including an arcuate surface extending in a direction from the first end to the second end and defining a peak aligned with the first and second portions of the first sidewall.

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